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The State of Probabilistic Flood Hazard Assessment: Data; Physics; Statistics; and Uncertainty

RIC 2013
March 12, 2013

Tim Cohn
USGS

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Topic of Interest: Riverine Flooding

Verde River (AZ), 1993

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3

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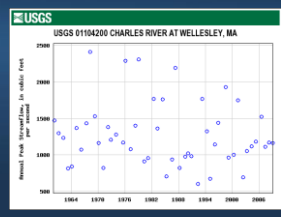
The Fundamental Problem

- We Have *Short* Records of *Past* Floods
- We Want to Characterize *Future* Floods with *Long* Return Periods



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State of the Practice

- Identifying and quantifying flood hazards
  - Extreme events (AEP 10^{-2} to 10^{-3})
  - Extremely extreme events (AEP 10^{-4} to 10^{-6})
- Acknowledging events not historically observed or anticipated ("Black swans," "Noah effect")
- Uncertainties

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Approaches

1. Pure Physical Theory
2. Calibrated Physical Theory (= Data + Physics)
3. "Conceptual" Models (Regression)
4. Pseudo-Probabilistic Methods (PMF)
5. Stochastic Methods (Data + Statistics)

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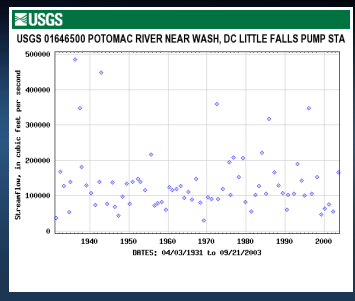
Flood Data: Annual Peak Flows



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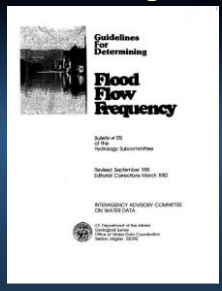
Estimating Flood Risk



History:

- 1967 Bulletin 15
- 1976 Bulletin 17
- 1977 Bulletin 17A
- 1981 Bulletin 17B
- 2012 (?)

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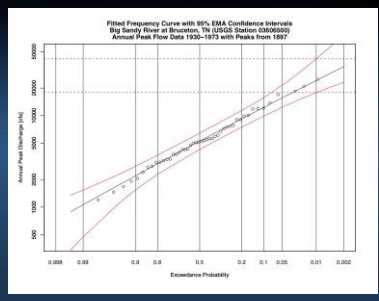
Flood Data with Fitted Distribution



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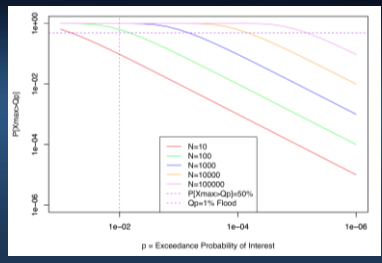
Probability of Observing Event of Interest in a Sample of Size N



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11

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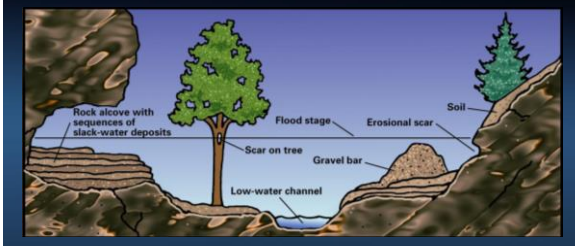
Is Additional Data Available?



Jarrett (1991) USGS Water-Supply Paper 2375
House et al. (2002) AGU Paleoflood Monograph

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Rapid City, South Dakota, 1972

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13

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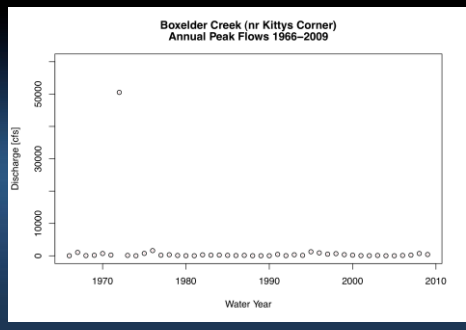

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14

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Searching for Paleoflood Evidence

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http://sd.water.usgs.gov/projects/Paleoflood/paleoflood.html

15

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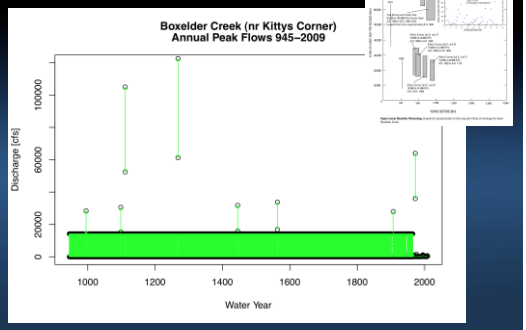

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Why Paleoflood Data Are Useful

- Reveal character of right-hand tail of flood frequency distribution
- Inexpensive
- Available now (maybe)
- We know how to use them

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Quantile Estimates and Confidence Intervals for 0.2% Flood

Period of Record	$Q_{0.99}$	95% Confidence Interval	
1966-2009	104,000	15,100	429,000,000
1946-2009	63,400	12,100	28,100,000
1904-2009	64,500	14,800	7,320,000
945-2009	37,400	19,800	108,000
1966-2009*	5,460	2,150	91,400

* 1972 flood omitted

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Impediments to Implementation

- Shortage of expertise
- Inadequate training/curricula
- Inconsistent definitions
- Culture ("Just try it…")
- Lack of imagination

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Need for multidisciplinary teams

- No one person has all necessary expertise
- Effective approaches may include
  - Hydrologists
  - Meteorologists
  - Paleohydrologists
  - Statisticians
  - Modelers
  - …

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Concerns

- Delusional Precision
  - If we're going to present uncertainties, we had better compute them correctly
- Terminology matters ("risk," "uncertainty," etc.)
- Education: Training future analysts
- Uncertainty

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Uncertainty

- For events that are frequent with respect to our data, aleatory uncertainty limits our ability to predict future events
- For rare (10^{-4} to 10^{-6}) events, epistemic uncertainty begins to be important
- One need to consider both aleatory and epistemic uncertainty
- Point estimates (PMF) are comforting but, by ignoring epistemic uncertainty, foster false sense of confidence

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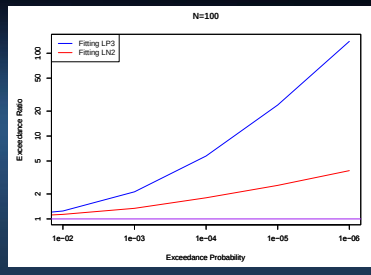
Does Epistemic Uncertainty Really Matter?



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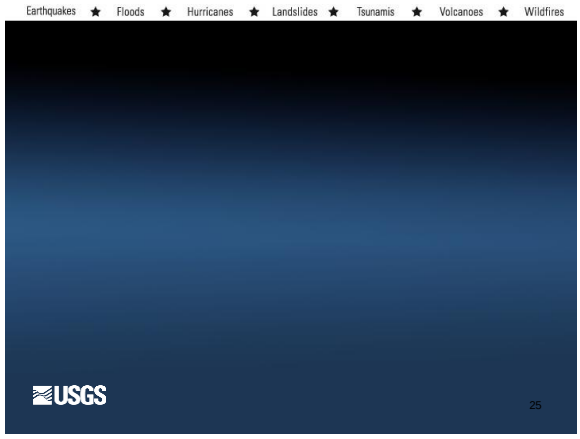
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25